

CLAIMS:

1. A thermostat malfunction detecting system of a cooling system of an internal combustion engine for detecting a malfunction of a thermostat provided in a coolant circulating path of an engine, comprising:

coolant temperature detecting means for detecting a coolant temperature on the path for circulating the coolant on the engine side from said thermostat; and

open-malfunction detecting means for diagnosing said thermostat whether it has a malfunction by which it is kept opened based on the engine side coolant temperature detected by said coolant temperature detecting means in a temperature range in which said thermostat is to be normally closed.

2. The thermostat malfunction detecting system of the engine cooling system according to Claim 1, wherein said open-malfunction diagnosing means determines a decrease or a rate of drop of the engine side coolant temperature right after the start of the engine and diagnoses whether said thermostat has the open-malfunction based on the decrease or the rate of drop of the engine side coolant temperature.

3. The thermostat malfunction detecting system of the engine cooling system according to Claim 1, wherein said open-malfunction diagnosing means determines an increase of the engine side coolant temperature until when any one of an elapsed time after the start of the engine, the number of times of ignition

and an accumulated value of quantity of heat generated by engine reaches a predetermined value and diagnoses whether said thermostat has the open-malfunction based on the increase of the engine side coolant temperature.

4. The thermostat malfunction detecting system of the engine cooling system according to Claim 1, wherein said open-malfunction diagnosing means determines any one of an elapsed time after the start of the engine, the number of times of ignition and an accumulated value of quantity of heat generated by engine until when the increase of the engine side coolant temperature reaches a predetermined value or until when the engine side coolant temperature reaches a predetermined temperature and diagnoses whether said thermostat has the open-malfunction based on a reference value.

5. The thermostat malfunction detecting system of the engine cooling system according to Claim 1, wherein said open-malfunction diagnosing means determines the increase of the engine side coolant temperature after the start of the engine and diagnoses whether said thermostat has the open-malfunction based on a number of times when the increase of the engine side coolant temperature becomes less than a predetermined value.

6. The thermostat malfunction detecting system of the engine cooling system according to Claim 5, wherein said open-malfunction diagnosing means determines the increase of the

engine side coolant temperature by either one of the increase of coolant temperature per predetermined time, the increase of coolant temperature per predetermined number of times of ignition and the increase of coolant temperature per predetermined quantity of heat generated by engine.

7. The thermostat malfunction detecting system of the engine cooling system according to Claim 1, wherein said open-malfunction diagnosing means corrects data used for the diagnostic process of the open-malfunction based on at least any one of a vehicle speed, an outside air temperature, an intake air temperature and the operating state of an air-conditioner.

8. The thermostat malfunction detecting system of the engine cooling system according to Claim 1, further comprising:  
closure-malfunction diagnosing means for diagnosing whether said thermostat has a closure-malfunction in which said thermostat is kept closed based on the engine side coolant temperature detected by said coolant temperature detecting means in the temperature range in which said thermostat is to normally open.

9. The thermostat malfunction detecting system of the engine cooling system according to Claim 2, wherein said open-malfunction diagnosing means diagnoses the malfunction after an elapse of a predetermined time from a start of the engine.

10. The thermostat malfunction detecting system of the engine cooling system according to Claim 2, wherein said open-malfunction diagnosing means diagnoses the malfunction while the engine is in an idle state.

11. A thermostat malfunction detecting system of a cooling system of an internal combustion engine for detecting a malfunction of a thermostat provided in a coolant circulating path of the engine, comprising:

coolant temperature detecting means for detecting a coolant temperature on the circulating path for circulating the coolant on the engine side from said thermostat; and

closure-malfunction detecting means for diagnosing said thermostat whether it has a closure-malfunction in which it is kept closed based on the engine side coolant temperature detected by said coolant temperature detecting means in a temperature range in which said thermostat is to be normally opened.

12. The thermostat malfunction detecting system of the engine cooling system according to Claim 11, wherein said closure-malfunction diagnosing means determines the variation of the engine side coolant temperature after reaching the temperature range in which said thermostat is to be opened after the start of the engine and diagnoses whether said thermostat has the closure-malfunction based on the variation of the engine side coolant temperature.

13. The thermostat malfunction detecting system of the engine cooling system according to Claim 12, wherein said closure-malfunction diagnosing means determines the variation of the engine side coolant temperature by either one of the variation of coolant temperature per predetermined time, the variation of coolant temperature per predetermined number of times of ignition and the variation of coolant temperature per predetermined quantity of heat generated by engine.

14. The thermostat malfunction detecting system of the engine cooling system according to Claim 13, wherein said closure-malfunction diagnosing means diagnoses the closure-malfunction when an accumulated value of the quantity of heat generated by engine after the start of the engine reaches a predetermined value.

15. The thermostat malfunction detecting system of the engine cooling system according to Claim 11, wherein said closure-malfunction diagnosing means diagnoses the closure-malfunction when the engine side coolant temperature becomes higher than the valve opening temperature of said thermostat by a predetermined temperature.

16. The thermostat malfunction detecting system of the engine cooling system according to Claim 11, wherein said closure-malfunction diagnosing means corrects data used for a diagnostic process of the closure-malfunction based on at least

any one of a vehicle speed, an outside air temperature, an intake air temperature and an operating state of an air-conditioner.

17. The thermostat malfunction detecting system of the engine cooling system according to Claim 11, wherein a radiator fan for cooling a radiator provided on said path for circulating the coolant is an electrically driven fan and said malfunction diagnosing means diagnoses the closure-malfunction during the period in which said radiator fan is stopped.

18. The thermostat malfunction detecting system of the engine cooling system according to Claim 12, wherein said closure-malfunction diagnosing means determines the malfunction when the variation of the engine side coolant temperature is below a predetermined value after an accumulation of heat generated by engine reaches a predetermined value.

19. The thermostat malfunction detecting system of the engine cooling system according to Claim 18, wherein said closure-malfunction diagnosing means determines the malfunction when the variation of the engine side coolant temperature is below a predetermined value after a radiator fan is changed from ON to OFF.

20. The thermostat malfunction detecting system of the engine cooling system according to Claim 12, wherein said closure-malfunction diagnosing means calculates the variation of

the engine side coolant temperature each time heat generated by the engine reaches a reference and determines the malfunction when the calculated variation is smaller than a predetermined value.

21. A thermostat malfunction detecting system of a cooling system of an internal combustion engine for detecting a malfunction of a thermostat provided between an engine and a radiator on a circulating path for circulating a coolant for cooling the engine, comprising:

engine side coolant temperature detecting means for detecting a coolant temperature on the path for circulating the coolant on the engine side from said thermostat;

radiator side coolant temperature detecting means for detecting a coolant temperature on the path for circulating the coolant on the radiator side from said thermostat; and

malfunction diagnosing means for diagnosing said thermostat whether it has a malfunction based on the engine side coolant temperature and the radiator side coolant temperature detected by said engine side and radiator side coolant temperature detecting means.

22. The thermostat malfunction detecting system of the engine cooling system according to Claim 21, wherein said malfunction diagnosing means has open-malfunction detecting means for diagnosing said thermostat whether it has an open-malfunction in which said thermostat is kept opened in the temperature range

in which said thermostat normally closes.

23. The thermostat malfunction detecting system of the engine cooling system according to Claim 22, wherein said open-malfunction diagnosing means diagnoses said thermostat whether it has the open-malfunction or not during the period from the cold start of the engine to the time when the coolant reaches the temperature at which said thermostat opens.

24. The thermostat malfunction detecting system of the engine cooling system according to Claim 22, wherein said open-malfunction diagnosing means diagnoses said thermostat whether it has the open-malfunction or not based on a difference of temperature between the engine side coolant temperature and the radiator side coolant temperature detected by said engine side and radiator side coolant temperature detecting means.

25. The thermostat malfunction detecting system of the engine cooling system according to Claim 22, wherein said open-malfunction diagnosing means diagnoses said thermostat whether it has the open-malfunction or not based on a rate of change of the engine side coolant temperature and the radiator side coolant temperature detected by said engine side and radiator side coolant temperature detecting means.

26. The thermostat malfunction detecting system of the engine cooling system according to Claim 21, wherein said



malfunction diagnosing means has closure-malfunction detecting means for diagnosing said thermostat whether it has a closure-malfunction by which said thermostat is kept closed in the temperature range in which said thermostat normally opens.

27. The thermostat malfunction detecting system of the engine cooling system according to Claim 26, wherein said closure-malfunction diagnosing means diagnoses said thermostat whether it has the closure-malfunction or not after when the coolant reaches the temperature at which said thermostat opens from the cold start of the engine.

28. The thermostat malfunction detecting system of the engine cooling system according to Claim 26, wherein said closure-malfunction diagnosing means diagnoses said thermostat whether it has the closure-malfunction or not based on a difference of temperature between the engine side coolant temperature and the radiator side coolant temperature detected by said engine side and radiator side coolant temperature detecting means.

29. The thermostat malfunction detecting system of the engine cooling system according to Claim 26, wherein said open-malfunction diagnosing means diagnoses said thermostat whether it has the closure-malfunction or not based on a rate of change of the engine side coolant temperature and the radiator side coolant temperature detected by said engine side and radiator

side coolant temperature detecting means.

30. The thermostat malfunction detecting system of the engine cooling system according to Claim 21, wherein said malfunction diagnosing means has discriminating reference value setting means for setting a malfunction discriminating reference value based on at least one of operating condition of said engine, outside-air temperature, intake air temperature and operating condition of an air-conditioner.

31. A thermostat malfunction detecting system of an engine cooling system for detecting a malfunction of a thermostat provided in a coolant circulating path of an engine, comprising:

coolant temperature detecting means for detecting a coolant temperature on an engine side; and

malfunction diagnosing means for diagnosing a malfunction of the thermostat when the coolant temperature drops below a malfunction diagnosing temperature which is lower than a thermostat closing temperature after when the coolant temperature has reached the warm-up completion temperature.

32. The thermostat malfunction detecting system of the engine cooling system according to Claim 31, further comprising:

diagnosis inhibiting means for determining whether it is an operating state in which the coolant temperature inclines to drop and for inhibiting the discrimination of the malfunction implemented by said malfunction diagnosing means when it is the

operating state in which the coolant temperature inclines to drop.

33. A thermostat malfunction detecting system of an engine cooling system for detecting a malfunction of a thermostat provided in a coolant circulating path of an engine, comprising:

coolant temperature detecting means for detecting a coolant temperature on an engine side; and

malfunction diagnosing means for diagnosing the malfunction of the thermostat at least one of the occasions when the coolant temperature continuously rises even when a predetermined time has elapsed since the coolant temperature has risen above a thermostat opening temperature and when the coolant temperature continuously drops even when the predetermined time has elapsed since the coolant temperature has dropped below the thermostat closing temperature.

34. The thermostat malfunction detecting system of the engine cooling system according to Claim 33, further comprising:

load discriminating means for determining whether the present operating state is the low load range during which the coolant temperature drops and/or the high load range during which the coolant temperature rises; and

discrimination inhibiting means for inhibiting the discrimination whether the coolant temperature continuously rises above the thermostat opening temperature during the high load range and/or inhibiting the discrimination whether the coolant

temperature continuously drops below the thermostat closing temperature during the low load range.

35. The thermostat malfunction detecting system of the engine cooling system according to Claim 33, further comprising:

malfunction time control means for switching at least one of controls of an electronic throttle and of an air-conditioner to a mode when the malfunction of said thermostat is detected by said malfunction detecting means.

36. A thermostat malfunction detecting system of an engine cooling system which is applied to a vehicle provided with an electronic throttle for controlling an intake air amount and with an air-conditioner, comprising:

malfunction diagnosing means for diagnosing whether said engine cooling system has a malfunction or not; and

malfunction time control means for switching at least one of controls of said electronic throttle and said air-conditioner to a mode for controlling said engine cooling system when the malfunction of said thermostat is detected by said malfunction diagnosing means.